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PRODUCTION OF LOW-VISCOSITY TOMATO JUICE
[Tei-nen'sei tomato ju-su no seizo- ho-ho]

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[Claims] /*

[Claim 1] A production of low-viscosity tomato juice is characterized by the fact that tomato is ground or cut without being heated, is directly fed into an extruder with a screen pore size of 0.05~1.0 mm, and is squeezed under an outlet pressure of 10~20 kgf/cm^2 under conditions which satisfy the following expression 1.

[Expression 1]

$$0.10 < \log(P/L) < 2.0$$

{in Expression 1,

P: outlet pressure (kgf/cm^2)

L: screen pore size (mm)}

[Claim 2] In the production of low-viscosity tomato juice as described in Claim 1, an extruder with a screen pore size of 0.10~0.50 mm is used.

[Claim 3] In the production of low-viscosity tomato juice as described in Claim 1 or 2, juice squeezing is carried out under an outlet pressure within a range of 1.0~10 kgf/cm^2.

[Claim 4] In the production of low-viscosity tomato juice as described in Claim 1, 2, or 3, juice squeezing is carried out under conditions in which log(P/L) satisfies 0.30~1.5.

[Claim 5] In the production of low-viscosity tomato juice as described in Claim 1, 2, 3 or 4, the extruder is a biaxial different direction rotating type extruder.

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* Claim and paragraph numbers correspond to those in the foreign text.

[Detailed Explanation of the Invention]

[0001] [Field of Industrial Application]

This invention pertains to the production of low-viscosity tomato juice, and specifically, it pertains to a production of readily drinkable tomato juice, which contains approximately the same level of lycopene content as that of the existing product, and with a viscosity which is made lower than the existing one by markedly reducing the insoluble solids (pulp and so forth) in comparison to the existing product.

[0002] [Prior Arts]

In the past, as a production of tomato juice, generally, tomato was ground or cut, heated so as to deactivate the oxygen, and then squeezed using a centrifugal type juice extractor such as a pulper or a finisher. However, this existing type of method had shortcomings such that the viscosity of the tomato juice obtained was high; it was difficult to drink and increased one's reluctance to drink it. The viscosity of tomato juice is largely affected by the insoluble solids contained in it; the higher the insoluble solid content is, the higher the viscosity is. Hence, in order to obtain a readily drinkable tomato juice having a viscosity which was lowered by removing the insoluble solids as much as possible, squeezing the ground or cut tomato using a compression type juice extractor, for example, a filter press, was considered. In fact, when produced by a method such as this, a low-viscosity readily drinkable tomato juice

can be obtained. However, when tomato juice is produced by a method such as this, there are problems such that since lycopene is removed along with the insoluble solids, the color tone which is innate to tomato juice is not exhibited; that is, valuable lycopene whose bioactive functions have been attracting attention is removed.

[0003] Other production methods for vegetable juices including tomato juice, which have been proposed, include a method in which cut vegetable, without being ground, is squeezed by a compression type juice extractor (Kokai H4-58909); a method in which the ground or cut vegetable is fed into a biaxial different direction rotating type extruder, simultaneously carrying out both the deactivation of oxygen by heating and juice squeezing (Kokai H5-328949); and a method in which vegetable is roughly ground using a screw press and squeezed by pressing using a hydraulic press (Kokai H6-245746). According to these existing methods, depending on the juice extruder used, it is possible to obtain a readily drinkable tomato juice with a reasonably lower viscosity in comparison to the previously mentioned existing general method. However, even these existing methods have a shortcoming such that it is impossible to stably produce a readily drinkable tomato juice having a lycopene content which is approximately the same level as the previously mentioned existing general method, and a lower viscosity by markedly reducing the insoluble solid content in comparison to the case by the previously mentioned existing general method.

[0004] [Problem that the Invention Solves]

The invention aims to solve a point that the viscosity of tomato juice obtained by the existing methods was high due to the high insoluble solid content, making the juice hard to drink; and/or a point that it is impossible to stably produce a readily drinkable juice which has approximately the same level of lycopene content as that of a high-viscosity tomato juice and has a markedly lower viscosity than that of the high-viscosity tomato juice.

[0005] [Means to Solve the Problem]

The inventors, as a result of studies to solve the above problems, found that it is evidently suitable to directly feed ground or cut tomato, without being heated, into an extruder which is mounted with a screen of a prescribed pore size, and squeeze the juice under prescribed conditions.

[0006] That is, this invention pertains to the production of low-viscosity tomato juice which is characterized by the fact that tomato is ground or cut, without being heated, is directly fed into an extruder having a screen pore size of 0.05~1.0 mm, and that the juice is squeezed under an outlet pressure within a range of 10~20 kgf/cm^2 under conditions which satisfy the following expression 1.

[Expression 1]

$0.10 < \log(P/L) < 2.0$

{in Expression 1,

P: outlet pressure (kgf/cm^2)

L: screen pore size (mm)}

[0007] In this invention, tomato is ground or cut and fed into an extruder. Grinding or cutting is carried out so that the ground or cut size becomes slightly smaller than the screw pitch of the extruder as mentioned below. This is to facilitate the feeding of the ground or cut tomato into the extruder and the juice squeezing by the extruder.

[0008] In this invention, tomato is ground or cut and, without being heated, is directly fed into an extruder. When the ground or cut tomato is squeezed after deactivating the oxygen by heat, the sap viscosity derived from pectin increases, providing a tomato juice with a higher viscosity to that extent. In the case of tomato juice with a high insoluble solid content which is obtained by the existing general method, in order to improve the external appearance by preventing the separation of insoluble solids, it is necessary to increase the sap viscosity; hence, before squeezing the juice, it is necessary to deactivate the oxygen by heating. However, since this invention aims to obtain a tomato juice with a reduced insoluble solid content, it is unnecessary to prevent the insoluble solids from being separated. In order to obtain a tomato juice with a reduced viscosity, an increase in the sap viscosity is rather inconvenient.

[0009] In this invention, as mentioned above, tomato is ground or cut and, without being heated, is directly fed into an extruder and squeezed. The extruder to be used is a publicly known one which is

equipped with a screw which is rotatably supported by an axis, a screen mounted so as to surround the screw, an inlet which is provided to one end part of the screen in order to feed the ground or cut material between the screw and the screen, and an outlet which is provided to the other end part of the screen in order to discharge the squeezed residue of the ground or cut material from the space between the screw and the screen, and a covering material which is attached to the outlet in order to adjust the opening degree of the outlet. Extruders like this include a uniaxial rotary type, in which one screw is supported by the axis; a biaxial same direction rotating type, in which two screws which engage with each other and rotate in the same direction are supported by the axes; and a biaxial different direction rotating type, in which two screws which engage with each other and rotate in different directions are supported by the axes. Among these, the biaxial different direction rotating type extruder is preferable (JP-A (Tokkai) H6-190594, USP5417155).

[0010] For the extruder, one which is mounted with a screen having a pore size of 0.05~1.0 mm is used. It is preferable to use one to which a screen having a pore size of 0.10~0.50 mm is mounted. This is for the purpose of stably obtaining a readily drinkable tomato juice which has approximately the same lycopene content as that of the existing product and a lower viscosity by drastically reducing the insoluble solid content in comparison to the existing product, while retaining a reasonable juice squeezing rate in

relation to the juice squeezing conditions mentioned below.

[0011] In this invention, ground or cut tomato, without being heated, is directly fed to the extruder and is squeezed under an outlet pressure within a range of 10~20 kgf/cm^2, preferably 1.0~10 kgf/cm^2, under conditions in which the relationship between the screen pore size and the outlet pressure satisfies expression 1. The outlet pressure in this case means a pressure which is being applied onto the juice residue which has been practically squeezed off between the screw and the screen immediately before being discharged from the outlet. When the outlet pressure is less than 0.10 kgf/cm^2, the juice-squeezing rate is worsened; inversely when the outlet pressure exceeds 20 kgf/cm^2, it is practically impossible to carry out the smooth juice squeezing operation. Even if the screen pore size is within a range of 0.05~1.0 mm and the outlet pressure is within a range of 0.10~20 kgf/cm^2, unless the relationship between both of these satisfies expression 1, it is impossible to obtain a readily drinkable tomato juice which has approximately the same lycopene content as the existing product and a lower viscosity by markedly reducing the insoluble solid content in comparison to the existing product.

[0012] According to this invention, it is possible to stably obtain a readily drinkable tomato juice which has approximately the same lycopene content as that of the existing product and a lower viscosity by markedly reducing the insoluble solid content in

comparison to the existing product. Lycopene is found in cells constituting the insoluble solids. When squeezed using, for example, a filter press, in order to simply remove the insoluble solids, the insoluble solids can be certainly removed, but at the same time, lycopene is removed. However, as mentioned above, when ground or cut tomato is, without being heated, directly fed into an extruder having a screen pore size of 0.05~1.0 mm and is squeezed under the prescribed conditions, in the middle of squeezing, the cells forming the insoluble solids are ruptured mainly by being crushed; from the ruptured parts the lycopene moves into the squeezed juice. As a result, a tomato juice having approximately the same lycopene content as the existing product can be obtained. On the other hand, the cells forming the insoluble solids are simply ruptured; the insoluble solids are not made microscopically small; hence the insoluble solids, without passing through the screen, are discharged from the output of the extruder as the juice residues; as a result, a readily drinkable tomato juice with a lower viscosity by markedly reducing the insoluble solid content in comparison to the existing product can be obtained.

[0013] [Example Embodiments]

Example Embodiment 1

Tomato is washed, sorted, and ground using a crusher. The crushed material was, without being heated, directly fed into a biaxial different direction rotating type extruder to which a screen

having a screen of 0.10 mm pore size is mounted, and was squeezed under 5.0 kgf/cm^2 outlet pressure, hence conditions satisfying log(P/L) = 1.7 in the said expression 1. Of the juice liquid (tomato juice) thus obtained, the measurements or analysis results of the juice squeezing rate (weight%), insoluble solid content (weight%), viscosity (cp at 25 °C), soluble solid content (weight%) and lycopene (mg%) were as shown in Table 1; the results of sensory evaluation were also shown in Table 1.

[0014] Example Embodiments 2~9 and Comparisons 1~6

In the same manner as example embodiment 1, under the conditions shown in Tables 1 and 2, juice squeezing was carried out. Of the juice liquid (tomato juice) obtained, the results are as shown in Tables 1 or 2.

[0015] [Table 1]

Classification	Exemplary Embodiments								
	1	2	3	4	5	6	7	8	9
Pore size (mm)	0.10	0.50	0.90	0.50	0.50	0.50	0.10	0.50	0.20
Outlet pressure (kgf/cm2)	5.0	5.0	5.0	1.0	10.0	15.0	0.20	10.0	15.0
Log (P/L)	1.7	1.0	0.74	0.30	1.3	1.5	0.30	1.3	1.9
Juice squeezing rate (weight%)	80	80	85	75	80	85	70	80	80
Insoluble solid content (weight%)	0.2	0.2	0.3	0.2	0.2	0.2	0.1	0.2	0.2
Viscosity (cp)	5	7	10	7	7	8	5	7	6
Soluble solid content (weight%)	5	5	5	5	5	5	5	5	5
Lycopene (mg%)	7	8	9	8	8	9	7	8	8
Sensory Evaluation (persons)	29	-	20	23	25	22	22	25	23

[0016] [Table 2]

Classification	Comparisons					
	1	2	3	4	5	6
Pore size (mm)	0.03	1.2	0.02	0.50	0.40	0.10
Outlet pressure (kgf/cm2)	2.0	5.0	0.05	25	0.45	20
Log (P/L)	1.8	0.62	0.40	1.7	0.05	2.3
Juice squeezing rate (weight%)	20	85	-	-	40	90
Insoluble solid content (weight%)	0.1	0.5	-	-	0.2	0.1
Viscosity (cp)	5	25	-	-	7	4
Soluble solid content (weight%)	5	5	-	-	5	5
Lycopene (mg%)	4	9	-	-	8	4
Sensory Evaluation (persons)	9	2	-	-	23	6

[0017] In Tables 1 and 2,

Sensory evaluation: A total of 50 panel members consisting of 25 men and 25 women compared tomato juice of example embodiment 2 with tomato juice from the respective other embodiments and conducted sensory evaluations to determine which is preferable as tomato juice; the number of persons who preferred the other embodiments was shown (same applies to the following).

Comparisons 3 and 4: it was impossible to squeeze juice.

Comparison 5: The juice-squeezing rate was poor.

[0018] Comparison 7

Tomato was washed, sorted, and ground using a crusher. The ground material was heated to 75 °C to deactivate the oxygen, and then fed into a pulper, which is mounted with a screen of 0.5 mm pore size; the juice was then squeezed at 800 times/minute of revolution under 0 kgf/cm^2 outlet pressure. Of the squeezed juice liquid (tomato juice) thus obtained, the juice squeezing rate was 85 weight%; the insoluble solid content was 0.5 weight%; the viscosity was 23 cp; the soluble solid content was 5 weight%; the lycopene content was 10 mg%; and the results of the sensory evaluation were two people.

[0019] Comparison 8

The squeezed juice liquid (tomato juice) obtained in Comparison 7 was separated by a centrifugal separator at 3,000 times/min. x 10 minutes and the supernatant liquid was collected; of the collected liquid, the insoluble solid content was 0.2 weight% while the lycopene content was 3 mg%; the results of the sensory evaluation were five people.

[0020] Comparison 9

Tomato was washed, sorted, and diced into 3 mm squares using a dicer. The diced material was placed in a filter cloth and fed into a juice press machine and squeezed under 5 kgf/cm^2 pressure. Of the squeezed liquid (tomato juice) thus obtained, the insoluble solid content was 0.1 weight% while the lycopene content was 3 mg%; the results of the sensory evaluation were 3 people.

[0021] [Effect of the Invention]

This invention explained above clearly has an effect such that it is possible to stably obtain a readily drinkable tomato juice which has approximately the same level of lycopene content as that of the existing product and has a lower viscosity by markedly reducing the insoluble solid content in comparison to the existing product.